

# RECEPTION DATA SYNCHRONIZING APPARATUS AND METHOD, AND RECORDING MEDIUM WITH RECORDED RECEPTION DATA SYNCHRONIZING PROGRAM

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to a measurement of bit errors, and particularly, to acquisition of a synchronization between reception data past a DUT (Device Under Test) and expectation data by detecting synchronism patterns contained in the reception data and the expectation data.

### 2. Description of the related art

In cases of data communications by optical fibers there occurs a case causing a bit error. It is then necessary to detect the bit error to be corrected. Fig. 8 shows a system arrangement for making a detection of bit error.

A first pattern generator 52 gives electric data to a DUT (device under test as an element to be measured) 60. The DUT 60 has an E/O (electric/optic) converter 61, O/E (optic/electric) converter 62, and an optical fiber 63. The electric data given to the DUT 60 is converted by the E/O converter 61 into light, which is transmitted through the optical fiber 63 and returned by the O/E converter 62 again into electric data. The data output from the DUT 60 is called reception data.

A second pattern generator 54 generates expectation data for collation with the reception data. At a collator 56, the reception data is collated with the expectation data to find part of the reception data inconsistent with the expectation data, if any, as an inconsistent part to be a bit error.

At the collator 56, for collation between the reception data and the

expectation data, there is needed a synchronism to be obtained between the reception data and the expectation data. There is thus detected a synchronism pattern contained in the reception data, and the expectation data is generated in accordance with the detected timing, thereby obtaining a synchronism.

## SUMMARY OF THE INVENTION

However, the reception data contains also a false synchronism pattern, which is not a synchronism pattern, but has like data to the synchronism pattern. Or there is a case in which, due to a bit error of the reception data, a pattern different of data from the synchronism pattern is recognized as a synchronism pattern. Such a pattern can also be deemed as a false synchronism pattern. If an erroneous synchronization is resulted from a false synchronism pattern, there is an inconsistency in phase.

It therefore is an object of the present invention to provide a reception data synchronizing apparatus that allows a synchronization to be obtained between reception data and expectation data even with an inconsistency in phase due to a false synchronism pattern.

According to the present invention described in claim 1, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting position recording unit for recording a synchronism timing at which the synchronism pattern of the reception data is detected; a collation and synchronism decision unit for collating the reception data with reference data to decide whether or not the reception data is consistent in

phase with the reference data; and a synchronism control unit operative, when the collation and synchronism decision unit gives a decision for inconsistency in phase, for a match between a timing at which the synchronism pattern is detected after the synchronism timing recorded in the synchronism pattern detecting position recording unit and a timing of a synchronism pattern of the expectation data.

In a reception data synchronizing apparatus arranged as above-noted, even with an inconsistency in phase between reception data and reference data, it is after a synchronism timing at which a synchronism pattern when synchronized is detected that a detection of the synchronism pattern restarts to make the reception data and the reference data consistent in phase, thus allowing for the reception data to be synchronized with expectation data even with an inconsistency in phase due to a false synchronism pattern.

According to the present invention described in claim 2, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting timing recording unit for recording a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data; a collation and synchronism decision unit for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating unit operative, when the collation and synchronism decision unit gives a decision for inconsistency in phase, for a match between the synchronism pattern detecting timing recorded in the synchronism pattern detecting timing recording unit, as a subsequent one, and a timing of a synchronism pattern of the expectation data.

In a reception data synchronizing apparatus arranged as above-noted,

even with an inconsistency in phase between reception data and reference data, it is by a match between a next synchronism pattern detecting timing and a timing of a synchronism pattern of expectation data that the reception data and the reference data are made consistent in phase, thus allowing for the reception data to be synchronized with the expectation data even with an inconsistency in phase due to a false synchronism pattern.

Further, the next synchronism pattern detecting timing in record is used to render the reception data and the reference data consistent in phase, without the need of waiting a detection of synchronism pattern, thus allowing for a rapid synchronization to be obtained between the reception data and the expectation data.

The present invention described in claim 3, is a reception data synchronizing apparatus according to claim 2, wherein the timing generating unit transmits a predetermined reference timing signal, and the synchronism pattern detecting timing recording unit records the reference timing signal when the synchronism pattern is detected, as the synchronism pattern detecting timing.

According to the present invention described in claim 4, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording unit for recording a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as an initial one at which the synchronism pattern is initially detected; a collation and synchronism decision unit for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating unit operative, when the collation and synchronism

decision unit gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data from the synchronism pattern detecting timing, as the initial one, by the time difference recorded in the synchronism pattern detecting timing recording unit.

In a reception data synchronizing apparatus arranged as above-noted also, there can be obtained a synchronization between reception data and expectation data even with an inconsistency in phase due to a false synchronism pattern, like the invention of claim 2.

Further, a phase difference in record is used to render the reception data and reference data consistent in phase, without the need of waiting a detection of synchronism pattern, thus allowing for a rapid synchronization to be obtained between the reception data and the expectation data.

According to the present invention described in claim 5, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording unit for recording a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as a previous one at which the synchronism pattern is detected in a previous time; a collation and synchronism decision unit for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating unit operative, when the collation and synchronism decision unit gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data by the time difference recorded in the synchronism pattern detecting timing recording unit.

In a reception data synchronizing apparatus arranged as above-noted also,

there can be obtained a synchronization between reception data and expectation data even with an inconsistency in phase due to a false synchronism pattern, like the invention of claim 2.

Further, a phase difference in record is used to render the reception data and the reference data consistent in phase, without the need of waiting a detection of synchronism pattern, thus allowing for a rapid synchronization to be obtained between the reception data and the expectation data.

According to the present invention described in claim 6, a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting position recording step for recording a synchronism timing at which the synchronism pattern of the reception data is detected; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a synchronism control step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for a match between a timing at which the synchronism pattern is detected after the synchronism timing recorded in the synchronism pattern detecting position recording step and a timing of a synchronism pattern of the expectation data.

According to the present invention described in claim 7, a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting timing recording step for recording a synchronism pattern detecting timing at which the synchronism pattern is detected in the

reception data; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for a match between the synchronism pattern detecting timing recorded in the synchronism pattern detecting timing recording step, as a subsequent one, and a timing of a synchronism pattern of the expectation data.

The present invention described in claim 8, a reception data synchronizing method according to claim 7, wherein the timing generating step transmits a predetermined reference timing signal, and the synchronism pattern detecting timing recording step records the reference timing signal when the synchronism pattern is detected, as the synchronism pattern detecting timing.

According to the present invention described in claim 9, a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording step for recording a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as an initial one at which the synchronism pattern is initially detected; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data from the synchronism pattern detecting timing, as the initial one, by the time difference recorded in the synchronism pattern detecting timing recording step.

According to the present invention described in claim 10, a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording step for recording a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as a previous one at which the synchronism pattern is detected in a previous time; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data by the time difference recorded in the synchronism pattern detecting timing recording step.

According to the present invention described in claim 11, a computer-readable medium embodying a program of instructions for execution by the computer to perform a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting position recording step for recording a synchronism timing at which the synchronism pattern of the reception data is detected; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a synchronism control step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for a match between a timing at which the synchronism pattern is detected after the synchronism timing recorded in the synchronism



pattern detecting position recording step and a timing of a synchronism pattern of the expectation data.

According to the present invention described in claim 12, a computer-readable medium embodying a program of instructions for execution by the computer to perform a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting timing recording step for recording a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for a match between the synchronism pattern detecting timing recorded in the synchronism pattern detecting timing recording step, as a subsequent one, and a timing of a synchronism pattern of the expectation data.

The present invention described in claim 13, a computer-readable medium according to claim 12, wherein the timing generating step transmits a predetermined reference timing signal, and the synchronism pattern detecting timing recording step records the reference timing signal when the synchronism pattern is detected, as the synchronism pattern detecting timing.

According to the present invention described in claim 14, a computer-readable medium embodying a program of instructions for execution by the computer to perform a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the

reception data, includes: a phase difference recording step for recording a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as an initial one at which the synchronism pattern is initially detected; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data from the synchronism pattern detecting timing, as the initial one, by the time difference recorded in the synchronism pattern detecting timing recording step.

According to the present invention described in claim 15, a computer-readable medium embodying a program of instructions for execution by the computer to perform a reception data synchronizing method for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording step for recording a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as a previous one at which the synchronism pattern is detected in a previous time; a collation and synchronism decision step for collating the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating step operative, when the collation and synchronism decision step gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data by the time difference recorded in the synchronism pattern detecting timing recording step.

According to the present invention described in claim 16, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting position recording device that records a synchronism timing at which the synchronism pattern of the reception data is detected; a collation and synchronism decision device that collates the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a synchronism control device operative, when the collation and synchronism decision device gives a decision for inconsistency in phase, for a match between a timing at which the synchronism pattern is detected after the synchronism timing recorded in the synchronism pattern detecting position recording device and a timing of a synchronism pattern of the expectation data.

According to the present invention described in claim 17, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a synchronism pattern detecting timing recording device that records a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data; a collation and synchronism decision device that collates the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating device operative, when the collation and synchronism decision device gives a decision for inconsistency in phase, for a match between the synchronism pattern detecting timing recorded in the synchronism pattern detecting timing recording device, as a subsequent one, and a timing of a synchronism pattern of

the expectation data.

The present invention described in claim 18, is a reception data synchronizing apparatus according to claim 2, wherein the timing generating device transmits a predetermined reference timing signal, and the synchronism pattern detecting timing recording device records the reference timing signal when the synchronism pattern is detected, as the synchronism pattern detecting timing.

According to the present invention described in claim 19, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording device that records a time difference between a synchronism pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as an initial one at which the synchronism pattern is initially detected; a collation and synchronism decision device that collates the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating device operative, when the collation and synchronism decision device gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data from the synchronism pattern detecting timing, as the initial one, by the time difference recorded in the synchronism pattern detecting timing recording device.

According to the present invention described in claim 20, a reception data synchronizing apparatus for a synchronization to be obtained between reception data having a synchronism pattern for a synchronism to be obtained and expectation data as an expected value of the reception data, includes: a phase difference recording device that records a time difference between a synchronism

pattern detecting timing at which the synchronism pattern is detected in the reception data and the synchronism pattern detecting timing, as a previous one at which the synchronism pattern is detected in a previous time; a collation and synchronism decision device that collates the reception data with reference data to decide whether or not the reception data is consistent in phase with the reference data; and a timing generating device operative, when the collation and synchronism decision device gives a decision for inconsistency in phase, for shifting a synchronism timing of the expectation data by the time difference recorded in the synchronism pattern detecting timing recording device.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing the arrangement of a reception data synchronizer according to a first embodiment of the invention;

Fig. 2 is a status transition diagram showing actions of the first embodiment;

Fig. 3 is a diagram showing an example of obtaining a synchronization between reception data and expectation data of the first embodiment;

Fig. 4 is a block diagram showing the arrangement of a reception data synchronizer according to a second embodiment of the invention;

Fig. 5 is a status transition diagram showing actions of the second embodiment;

Fig. 6 is a diagram showing an example of obtaining a synchronization between reception data and expectation data of the second embodiment;

Fig. 7 is a block diagram showing the arrangement of a reception data synchronizer according to a third embodiment of the invention; and

Fig. 8 is a block diagram showing a system arrangement for performing a bit error detection in the prior art.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

### First Embodiment

There will be described below a first embodiment of the invention with reference to the drawings. First, there is described the arrangement of a reception data synchronizer according to a first embodiment. Fig. 1 is a block diagram showing the arrangement of the reception data synchronizer according to the first embodiment.

The reception data synchronizer 1 includes a collator 10, a synchronism decider 12, a synchronism pattern detector 14, a synchronism controller 16, a synchronism pattern detecting position recorder 18, and a second data generator 54.

The collator 10 performs a collation between input reception data and expectation data, detecting a different data between the two data, bit by bit, that is, for a detection of bit error.

The reception data input to the collator 10 is output from a first pattern generator 52 via a DUT 60. The DUT 60 includes an E/O (electric/optical) converter 61, an O/E (optical/electric) converter 62, and an optical fiber 63. At both ends of the optical fiber 63 are connected the E/O converter 61 and the O/E converter 62. To the E/O converter 61 is connected the first pattern generator 52, and to the O/E converter 62, the collator 10. The expectation data input to the collator 10 is input from the second data generator 54.

The synchronism decider 12 decides whether or not the reception data and